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Relative Areas of Star Discs in Photographs of the Pleiades.
By Henry, Trépied, and Roberts.

Star No.	Mag.		Henry.	Trépied.	Roberts.
39	6·4	Pickering.	25·00	32·11	4·00
3	6·7		21·39	28·44	4·00
32	6·6		20·25	28·44	4·41
2	6·9		20·25	25·00	4·00
42	6·9		18·06	21·80	4·00
6	6·6		16·00	21·80	4·00
7	7·5		14·06	16·00	3·61
17	7·5		13·14	14·70	3·24
19	7·9		13·14	12·25	3·24
27	7·4		12·25	20·25	4·00
35	8·0		12·25	13·44	2·56
9	8·1		11·39	12·25	2·56
25	7·8		11·39	16·00	3·61
24	9	Henry.	7·56	7·11	2·25
36	9		6·25	5·44	1·96
40	9		6·25	5·76	1·82
5	10		5·06	4·70	2·25
12	10		6·25	6·25	1·96
18	10		4·51	2·05	1·96
8	10		5·06	4·70	2·89
37	10		4·00	3·36	1·69
41	10		3·51	2·25	1·32
30	11		2·25	1·80	1·44
31	11		2·25	1·80	1·00
38	11		2·25	1·00	1·00
16	11		2·25	1·80	1·69
34	11		2·25	1·00	1·00
4	11		2·25	1·36	1·21
28	11		1·56	1·00	1·21
29	11		1·56	1·00	1·21
33	11		1·89	1·14	1·00
23	11		1·56	1·36	1·21
13	11		1·56	1·00	1·21
14	11		1·00	1·36	1·69

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Relative Areas of Star Discs in Photographs of a Region in Cygnus, by Henry and Roberts.

Star No.	Henry.	Roberts.	Star No.	Henry.	Roberts.
20	11·39	5·06	10	3·06	1·89
1	10·56	6·89	14	3·06	1·56
6	10·56	5·06	24	3·06	2·25
2	9·00	5·64	25	3·06	1·56
13	9·00	3·24	17	2·48	1·26
5	7·56	5·06	7	2·40	1·56
18	7·56	2·64	3	2·25	2·64
16	5·06	2·25	12	2·25	1·26
4	4·00	3·51	23	2·25	1·56
21	4·00	2·25	19	1·75	1·00
26	4·00	2·25	15	1·56	1·00
11	3·51	1·56	8	1·00	1·00
22	3·51	1·89			

Relative Areas of Star Discs in Photographs of the Cluster 35 *Messier Geminorum, by Henry and Roberts.*

Star No.	Henry.	Roberts.	Star No.	Henry.	Roberts.
4	9·00	2·8	18	2·25	1·80
15	7·56	3·36	2	2·25	1·36
12	5·47	2·25	13	2·00	1·56
24	5·06	2·51	3	1·80	1·36
23	4·70	2·25	6	1·80	1·36
19	4·34	2·80	17	1·80	1·56
11	4·00	2·25	9	1·36	1·36
7	3·36	1·80	14	1·36	1·36
16	3·36	2·00	10	1·17	1·36
5	2·80	1·80	20	1·17	1·36
1	2·80	1·56	8	1·00	1·00

Relative Areas of Star Discs in Photographs of the Nebula 1180 *H.G.C., by Henry and Roberts.*

Star No.	Henry.	Roberts.	Star No.	Henry.	Roberts.
17	58·8	9·90	18	2·80	1·65
1	28·44	6·61	9	2·25	1·65
12	25·00	7·40	15	2·25	1·65
5	21·80	6·61	6	1·80	1·00
8	11·11	5·20	10	1·80	1·30
4	4·00	3·00	11	1·80	1·30
7	2·80	2·50	2	1·36	1·15
13	2·80	2·50	3	1·00	1·00
14	2·80	2·00			

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It will be at once remarked that the *order* of magnitude is the same in both the reflector and the refractor photographs, but the *relative* magnitudes to the eye as judged by the size of disc are widely different—that is, the scale is different.

In the Pleiades, stars from the 7th to the 11th magnitude, which in the refractor photographs show a range of area from 25 to 1, in reflector photographs range from only 4 to 1. In the other photographs the magnitudes have not been photometrically determined, but the relative areas present a similar difference.

The comparison of the star discs in the photograph of the nebula N.G.C. 1977 has one point of interest, in that the measured diameter of the brightest star is nearly the same in both, and the scale of enlargement is about the same; but the relation of the areas of the smaller stars is very different.

In all the reflector photographs it will be found that there is an *equalisation* of the magnitudes, and the conclusion is arrived at that differences of brightness which are perceptible to the eye in telescopic observation are equally perceptible in refractor photographs, but except between much wider limits are not so perceptible in those taken with a reflector.

In considering the cause of this great difference in photographs of stars by the two forms of instrument, it is extremely unfortunate that we possess so little information as to the quality of photographic star-discs produced by reflecting telescopes, and there is not much literature on the subject. I am not aware of any other results available but those of Dr. Common, Dr. Roberts, and von Gothard, all employing telescopes of the Newtonian construction.

The Bulletin of the International Permanent Committee contains a paper, by Dr. Scheiner, On the Application of Photography to the Determination of Stellar Magnitudes, in which he compares photographs taken by von Gothard's reflector with those obtained with a 5-inch refractor at Potsdam. I think this is the only paper published that at all deals with the question under discussion.

Though von Gothard's photographs are on a smaller scale, with images by no means round, the results Dr. Scheiner gives from measuring the diameters entirely confirms what I have said, that in photographs taken with a reflector the *scale* of magnitude differs from that with a refractor; a fact that is well known, and that for a given range of magnitude there is less variation in the size of the discs in the former case than in the latter.

The explanation of this difference is not a very simple matter, but I do not think it difficult to point out a possible cause of the anomaly, which detracts so seriously from the value of the photographs under discussion.

Dr. Scheiner in the paper cited above discusses some of the causes in the refracting telescope which affect the photographic image of a star, and points out that the progressive enlargement

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of the discs with increased exposure cannot be due to the interference rings surrounding the star image. The explanation of this phenomenon may possibly be found in a lateral reflection of light from the particles of silver haloid, or to a chemical action between particles directly exposed to light and those in their vicinity.

The great advantage of a short-focus reflector for photographing nebulæ has been completely established by the remarkable results that Dr. Roberts has so successfully obtained. In photographing stars, however, the influence of the arms supporting the flat has never been thoroughly considered or investigated. All observers with reflectors of this construction know that the images of stars are never perfect, that there is always more or less of *flare* to the image, and though the seeing may be very good, the image on close examination is never a perfect one, but irregular and uneven. In bright stars the imperfection of the image is seen to be due to the six or eight rays radiating from them, caused by the arms of the flat. The same cause will operate with the fainter stars—less visibly to the eye, but revealed in a photograph of long exposure. The short focus is also less favourable for the production of perfect star images; and the adjustments generally of a reflector are of an extremely delicate nature. The phenomenon of interference rings has also been shown to be present in the reflector image, and this still further complicates the question.

It is, I think, to a combination of these defects that we must seek for a solution of the above anomaly. It seems probable, and I think demonstrable, that the Newtonian reflector photographs stars in their true relative brightness, *plus* a certain amount of flare in each case, due mainly to the scattering of light by the arms supporting the flat; in other words, the stars are photographed in their true relative brightness *plus a constant*, which would at once explain the difference of scale and the equalising of the magnitudes. It was most truly remarked the other day, by Sir Howard Grubb, that "in the photographic method the record of the observation is not that of any one moment; it is the aggregate of all the impressions made every second, and every part of a second, during the exposure. The photographic plate, unlike the eye, takes note of and records every position of the star image." The photographs under consideration faithfully record all the defects of the imperfect image formed by the Newtonian reflector, with the result that they do not present to the eye a true portrait of the object, so far as the relative brightness of the stars is concerned.

It would be a most interesting and instructive line of research to photograph stars with a reflector of the Herschelian construction. The baleful influence of the flat, with its adjustments and supports, would be eliminated, and the true value of a mirror for astronomical photography would be determined far more accurately than has yet been the case.

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On the Formation of Photographic Star-Discs.

By H. F. Newall, M.A.

It is probably generally admitted that the formation of photographic star-discs is not yet understood. A telescope which ought theoretically to give a spurious disc, whose diameter is, let us say, 1″, gives in practice a photographic disc whose diameter increases with the brightness of the star and the exposure given to the plate, and may reach a value approaching or even exceeding 60″—a statement which is true not only of refractors but also of reflectors. This is a defect, and a very serious defect for some investigations; on the other hand, in some cases it is a positive advantage, and astronomers make the best of the peculiarity by basing estimations of star magnitudes upon it. It is difficult to form an idea as to how much labour and trouble in such an undertaking as the making of the Photographic Chart is saved by the existence of these expanding photographic discs. One may almost say that it has now come to be a distinct merit in an instrument that it should give expanding discs.

In applying photography to the determination of parallax it would clearly be an advantage to get more point-like images both of bright stars and of faint stars with a given exposure. Hence it would appear to be of considerable importance to advance, if possible, to a knowledge of the secret of the formation of expanding photographic discs, and I beg leave to lay before the Society an account of some experiments and measurements bearing on the subject.

The importance of a vigorous attack on the subject is obvious, inasmuch as there are many proposals to build large photographic telescopes. Let me instance the 18-inch photographic telescope suggested for the Cambridge Observatory, and the 26-inch photographic telescope for Greenwich. It is not quite clear that from such telescopes results may be expected proportionate to the dimensions and cost of such instruments, unless some departure is made from the existing mode of construction of the object-glass. A larger scale in the photograph, in which everything is equally magnified, not only separation of star-centres, but also disc diameters, would not bring much advantage.

One of the most notable points about a good photographic star-image is the definiteness of the boundary of the disc, whatever its diameter may be. In the case of a prolonged exposure the image of a bright star may readily come to have a diameter exceeding 1 millimetre on the photographic plate. Yet the distance (measured along the radius) in which the density of silver deposit changes from full value to zero is a very small fraction of the radius of the disc.

Scheiner has recently published an important paper, "Ueber